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ANNALS

OF THE

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VOLUME XVII MARCH 1927 No. 1

THE MAP AS A RECORD OF PROGRESS IN GEOGRAPHY

BY

J. PAUL GOODE

THE ANTIQUITY OF MAP MAKING.—The map is a written language expressed in a system of shorthand. In its earlier forms it was usually pictographic, and this one trait has clung to it throughout the ages. So nearly as we may tell from the study of primitive cultures, the making of a map is as old as any other form of picture writing. In fact it has been considered close to a primitive instinct. And as a form of graphic expression it was practiced in every geographic realm from the most ancient times, along the Nile, and the Euphrates, in far Tahiti, in the Mayan culture of Mexico, and among the Eskimos of the northern islands. Babylonian surveyors four thousand years ago made quite accurate descriptions of estates, indicating metes and bounds, and making record on clay tablets which are still extant in our museums. Similar surveys in Egypt at a date only a little less remote are recorded on papyrus, showing the irrigation canal leading to Lake Moeris, and the location of towns on the lake border.

But these cadastral maps of Babylonia and Egypt were of relatively small areas, on which distances could be measured by pole or chain, or by pacing, and in which the records were susceptible of considerable accuracy.

On larger expanses where a measuring stick could not be used the problem was more difficult. But even here primitive men have not hesitated to attempt picture representation of space relations. To give only one illustration. My friend, Dr. George A. Dorsey, told me a number of years ago of an interesting find amongst the Plains Indians.

Presidential Address, Association of American Geographers, Philadelphia, December 29, 1926

It was the Pawnee tribe, I think, he was studying. He was elected a member of the tribe, and also a medicine man. When he was initiated he was shown the treasures in the holy of holies. These treasures were kept in a buffalo skull, and one of them was a star chart on fine buckskin. More than a thousand stars were entered, and so accurately was the work done that when he was permitted to bring the chart to his colleagues in astronomy, they could make a fair estimate from the positions of the planets that the chart had been made about the time of the discovery of America. Thus the Plains Indians taking their course from the stars by night, like the shepherds of old in the Orient, produced a map of the heavens which compares very well with the famous Egyptian star chart of Ptolemy's time.

Among the Greeks.—So widespread and so ancient the map idea is known to be, we must read with a grain of salt the statement of the early historians, that Anaximander (ca 580 B. C.) *invented* the map, and that he was the first person who attempted to represent the surface of the earth in map form. Rather was it that Anaximander, and Aristagoras about a century later (ca 499 B. C.) with his map of the world engraved on a bronze tablet, merely illustrate the truth of Emerson's wise saying: "'Tis his at last who says it best." Nor does this observation imply any lack of appreciation of the tremendous task these early Greeks set themselves in attempting to portray in graphic form, and in definite space relations, the seas, islands, countries, rivers, and cities of the known world of their time. With no adequate means of taking latitudes, and with the crudest of substitutes for longitudes; with only sailors' reports of the trend of coasts (and that without a compass), with distances measured on the sea by "days of sailing," and on dry land by "days of marching," it is a marvel that they fared so well at mapping as they are reported to have done. Accurate mapping, even if in two dimensions only, depends upon the establishment of true latitude, true longitude, and accurate linear measurement. One can have only profound respect for the clear thinking of these early Greeks. When geometry was young, and mensuration was hardly yet born, they saw clearly that mapping required definite knowledge of the shape and size of the earth, and the latitude and longitude of places, and they set themselves to supply these data. They had proven the earth a sphere. With nothing more accurate than a gnomon, or sun dial, they were determining latitudes. Pytheas (330 B. C.) read the latitude of Massilia true within a fraction of a minute of arc. A few years later Dicearchus, a pupil of Aristotle, took the ele-

vation of certain stars for an arc of the meridian, estimated the length of this arc, and computed the meridian circumference of the earth at 30,000 miles. It was merely a refinement of method which Eratosthenes applied about a century later in his classic attempt, which made the circumference of the earth 25,000 geographic miles, only about one-seventh too large. This was looked upon by the scholars of the time as an extraordinary achievement, and we, who are accustomed to all manner of instrumental and technical refinements, need not hesitate to applaud with earnest appreciation that intellectual accomplishment.

In the Roman Period.—By the time Rome had spread her sway over all the countries about the Mediterranean, and found on almost every frontier new realms to conquer, there was more than ever a need, a demand, for better maps. About the middle of the second century of our era, a great genius arrived in the person of Marinus of Tyre, who undertook to carry out the great program of mapping, attempted by Hipparchus (ca 140 B. C.) three hundred years before, of making an adequate map of the world, with latitudes and distances and directions refined. Although his work is lost, his inspiration lives in the work of Claudius Ptolemy, his immediate successor, the greatest cartographer of the ancient world.

The Work of Ptolemy.—By the time Ptolemy took up the task, the latitudes of many places had been quite accurately determined, and in the great library of Alexandria had been accumulated a marvelous mass of written records of travel and trade, upon which to draw for estimates of distance and direction between places. But think of the infinite labor of checking one sailor's estimate of a "day's sail" against another, and of travelers' or commanders' estimates of "day's marches." We who are making maps at the present time may well grant unstinted praise to the labors of these fathers of old. The great maps of Ptolemy are crowded with names, showing the intimate and widespread knowledge of the countries mapped.

Ptolemy had the misfortune to follow Posidonius (ca 130 B. C.), one of the most brilliant travelers and scholars of antiquity, who had undertaken to recompute the size of the earth after the method of Eratosthenes. But the observations were so crude, and the estimates of distance by land and sea so uncertain, that his determination reduced the circumference of the earth to about 21,000 miles, or one-sixth too small. The adoption of this estimate by Ptolemy fixed the small size of the earth in men's minds for the next 1,400 years, or until the great renaissance following Columbus.

The work of Ptolemy came at a critical time. The golden age of Greece was over. The stream of her great intellects had been dried up at its source. Physical and political power had been passed on to Rome. And Rome, bred in the brutality and greed of war, was already in physical and intellectual decline. So the work of Ptolemy stood out with the luster of the last of a great line. For centuries he was the last word in maps, and no one thought of any other authority in cartography. Although new maps were added to his collection from time to time, all such collections were called "Ptolemies" until after the time of Gutenberg.

The work of Marinus and Ptolemy gave the world maps with fixed parallels of latitude and meridians as bases for location of known points, and the difficulties of map projection began to be realized. Marinus mapped his Mediterranean world on a grill of straight lines, at first crossing each other at right angles. Later, in an attempt at greater accuracy, the distances between meridians were shortened in higher latitudes, the meridians still remaining as right lines. But when knowledge of the earth had extended to far Taprobane, and China had been heard of beyond, distortions in shape by this device became too great, and in his later maps Ptolemy introduced concentric arcs for parallels, and curved meridians, giving much better shapes, and making a more presentable map.

Map-Making in the Dark Ages.—The period of a thousand years which followed Ptolemy is just as drab and witless in cartography as in any other line of science or human endeavor. The "fundamentalism" of the time lay like a blight upon the minds of men. There was no independence of thought, no initiative. The pictographs which served as maps were pitifully childish things. Doubtless the so-called maps of the time were as good an index of the status of the geography of the time, as can be found. All the glorious contributions of the ancient Greeks were anathema. Not until Marco Polo at the close of the thirteenth century came back from his marvelous journeys over all Asia, were men's minds fired again with the great geographic urge, to see and map the unknown parts of the world. Yet it took more than fifty years for Polo's work to get cartographic recognition.

The Revival of Map Making.—An exception to the general rule of imbecility in cartography must be made in the latter part of this period of intellectual gloom, in the case of the mariners and merchants of the western Mediterranean, who, following closely the lead of Ptolemy, by constant correction of positions, had arrived at rather

remarkable maps, the portolano charts of Majorca and the Catalonian towns. Much of this improvement is patently due to the use of the mariner's compass, which had slipped into the Mediterranean, unobtrusively, in the twelfth century. This made possible very much more accurate determinations of direction between places, and of trend of coasts. The increased activity of the mariners of the time was doubtless due in large measure to the use of keeled ships, for the keel had come down the coast from Norway and into the Mediterranean, about the same time, and as unobtrusively as the compass had done. With keel and compass the mariner could set out boldly for his destination across the sea, without " waiting for a favoring wind," and without the need of keeping in sight of land. So the maps of the time record again the reawakening interest in the world at large and the rebirth of geography.

Makers and students of maps are under deep obligation to Baron Nordenskjold for his reproductions of Ptolemies, and other ancient maps, and to Dr. Edward L. Stevenson for the exact reproduction of many scarce and valuable maps of the great age of renaissance in cartography.

THE MAP AN EPITOME OF GEOGRAPHIC EXPLORATION AND INTELLECTUAL AND MECHANICAL DEVELOPMENT.—It is interesting to observe all the way along, that the map has grown in importance in geographic education just in proportion as our knowledge of the world at large has grown, and just in proportion as the methods of map production have made possible the multiplication of maps, so bringing them into use by larger numbers of students.

Also it will be noticed that the map represents in its making, and in its quality, the progress made in other lines of science, especially mathematics, and in the instruments and technique of mensuration. In its historical development the map reflects closely the progressive development of engraving and printing; and finally, in its varied present forms, the map records the place it has won in scientific and general education. It may not be amiss to take note of some of these interrelations.

Influence of Invention of Printing.—In the great intellectual awakening which followed the invention of printing, and the discoveries growing out of the quest for a sea route to the Indies, geography and cartography were tremendously stimulated. The discovery of new lands called for continual additions to the map of the known world. With mariners plowing every sea, the difficulty of getting accurate bearings, and of laying a course led to continual tragedy. Then again

imperfect mapping was followed often by international friction. Spain and Portugal were at sword's points in laying claim to the newly discovered lands. Yet when in 1524 a congress of negotiators met to interpret the papal bull of 1493, which was to divide the New World from the Old on a meridian 370 leagues west of the Cape Verde Islands, the congress failed utterly, because they could not agree either on the length of a league nor the establishment of a meridian.

New Instruments for Observations.—But progress had been making in mathematics, and in the instruments of mensuration. In the taking of latitudes at sea the quadrant had recently replaced the astrolabe of the ancients, and the clumsy cross staff which was the common instrument of the time. Very much better latitude readings were the result. As to the magnitude of the degree of arc of the meridian, and the consequent size of the earth, very little had been done since the time of Eratosthenes. But the deficiency here was a spur to live thinking men. One of them, Jean Fernel (1497-1588), a famous French physician, undertook to measure a degree arc of the meridian. Choosing a level plain in northern France, he took the latitude of two stations on a meridian, and rolled a carriage wheel the whole distance between them. The result gave a meridian circumference of the earth very nearly correct, and the world map could begin to show the earth's surface on the true scale. Although this result was vastly better than what had been in use hitherto, it was too crude to serve as a basis for careful geodetic work, yet the world waited one hundred twenty years for a better determination.

The Introduction of Triangulation.—A very beautiful application of mathematics to surveying came from Holland in 1617 when Snell introduced triangulation and the solution of triangles by trigonometry. This was the foundation of modern geodetic surveying, by which the fundamental positions are located, and to which all later positions are referred, in the making of an accurate map. Such work called for the exceedingly accurate measurement of angles. The French and the English vied with each other in the making of astronomical and other instruments. The theodolite came into use in 1571; the vernier was added to it in 1631; the telescope was added after 1643; and the crossed wires in 1669, completing the instrument in its modern form. So bit by bit the problem of exact latitudes was solved.

The Importance of the Chronometer.—But the question of exact longitudes was more difficult. Not until 1735 was a timepiece constructed which was sufficiently accurate and portable to be used on long

voyages in the determination of longitude. Then John Harrison of London won the prize long offered by the British Government, with a chronometer of exceeding accuracy, which ranks as one of the finest contributions of human skill of all time. It is nothing short of marvelous how the world map straightened up and got rid of its deformities after the Harrison chronometer went to work. All longitudes were established by its use, until after the coming of the telegraph and cable, and now the final degree of accuracy science may hope for, is guaranteed by the radio.

Value of an Accurate Unit of Measurement.—It is of interest to note that the third requisite for accurate mapping, accuracy in linear measurement, also called for some of the finest of human skill. When Sir Isaac Newton announced that because the earth is in rotation, its form must be an oblate spheroid, and in such a case the length of the arc of a degree of the earth's meridian must be shorter at the equator and longer in high latitudes, the French Academy presently undertook to measure such arcs. It was found that there was no standard unit of length. The nearest to such a standard was the distance between two nicks on an iron wagon tire, which had been straightened out and nailed to the side of a house, on a side street in Paris. This situation led to the adoption of a standard, which presently led to the making of a standard meter, and the development of the metric system. And the final term in this quest was the calling of the brilliant young Michelson (in 1875) to express the length of the meter in terms of the wave length of the green spectrum light of mercury vapor. There probably will never be any more accurate measurement done. If the present standard meter should be lost, its value could be redetermined, even by a man from Mars, with almost absolute precision.

The Use of Projections.—Let us look now at some of the steps in the progress of the actual making of the map. First the matter of projections, and then the process of reproduction of the map. When the known world was very small there was little need of a projection. But the widening earth in the period of great discoveries called for better methods than those of Ptolemy. There came a period of intense activity in the making of maps and globes.

Mercator's Projection the Beginning of Modern Cartography.—The modern period in cartography begins with the Flemish map maker, Gerard Kramer. He had specialized in mathematics, had undertaken to do the surveying and to make a map of Flanders, better than any

other map had been. Much progress had been made toward the accumulation of accurate data. Kepler had published in 1526 a vastly improved ephemeris, therefore longitudes were in much better form. Fernel had given a fair value to the degree arc of the meridian. Kramer's maps were a wonderful improvement over earlier maps. So when the troubled merchants of the lowlands waited on him, with the complaint that the crude sailing charts in use were responsible for endless loss and woe, and asked him to provide a better sailing chart, an inspiration came to him, of using a central cylindrical projection, but keeping a constant ratio between the lengths of the arcs of degrees of the meridians and of the parallels of latitude. This would make it possible to draw a rhumb line between any two points, set the compass to the angle between this rhumb line and a meridian, give the ship this bearing, and sail straight to port. Any ship master could draw such a rhumb line and read the angle. No mathematics was required. The map was published in 1569 with the cartographer's name in the Latin form, Mercator, and was immediately recognized as a remarkable contribution. The projection is still the standard for sailing charts, and for such use there seems to be no likelihood of its ever being replaced by any other. But for most of the uses for which a geographer requires a map it is an evil Mercator just the same.

The World's Cartographic Centers in the Sixteenth Century.—Mercator's maps were engraved on copper and printed from the original plate. They were so well done that when collected by his successors and published in book form, with the title of "Atlas," it became at once the recognized authority, and the earlier map collections called "Ptolemies" went out of use. The fine map work of Mercator and his contemporaries made Antwerp and Amsterdam the world's cartographic headquarters, a distinction they held for nearly two centuries. And this in spite of excellent work being done in France by Sanson and others.

Method of Showing Relief.—With the refinement of the map in its primal two dimensions came the need of portrayal of relief, the third dimension. From the beginning mountains had been pictured as sugar loaves, or mole hills, and this convention, slightly disguised as caterpillars, held its own well into the nineteenth century. But in 1674 relief was pictured by a system of hachures, which was rapidly developed into a very beautiful method of portrayal of relief, best shown in restricted areas of strong relief. The system is much in favor still with European map makers. This method of showing relief is only one of eighty different devices proposed.

In 1728 the contour line was invented by Cruquius, a scientific contribution of large significance, though it escaped recognition until 1791, when Dupain-Triel used it in his map of France. It found little favor in Europe, however, waiting until mid-nineteenth century for recognition and development by American cartographers. More use has been made of it by our United States Geological Survey in the magnificent topographic atlas of the United States than in all the remainder of the world. The addition of color, green for lowlands, buff and brown for highlands, and so on, adds legibility and beauty, and makes of it the most attractive of maps. The device is strictly scientific and quantitative, though manifestly it can be used satisfactorily only for mapping regions in which the relief has been intimately provided with elevations by barometric readings, and recorded by plane table or photographic methods. Outside of America the method is shown at its best in Bartholomew's beautiful survey atlases of Britain, and in the superb topographic survey maps of Japan by the Japanese government. And now the system is adopted for the most monumental map venture of all time, the great international physical map of the world on the scale of one to a million. And of this we will speak again later.

The final term in the portrayal of relief is less than twenty years old, aerial photographic mapping. The late Willis T. Lee has put into the record for all time the great success of this method in mapping a difficult terrain, such as the tidal flats of New Jersey, and later the delta of the Mississippi. The method is well adapted to rapid reconnaissance survey, and was first successfully applied in an economic way to an appraisal of the wood pulp resource of northern Quebec. The priceless value of areoplane photographic mapping was first recognized by military men in strategic geography, and the military interest is the strongest one in the promotion of airplane service in times of peace.

Increasing Uses for the Map.—In other lines than the portrayal of land relief, the map has been brought into priceless service. In many lines of scientific survey the geographic presentation of areal distribution has been required. Thus the rise of the science of geology called at once for the areal mapping of the outcropping of the rocks of various ages. And the use of color and of areal pattern soon produced the conventional geological map. A vacant place in such a map is a constant challenge to further field work. The results of a century of such mapping give us a splendid series of geological maps, and there is now very little of the land surface of the earth left, which has not been either intimately mapped, or at least provided with reconnaissance survels.

Baron Humboldt early in the nineteenth century was first to chart atmospheric temperatures and pressures, using isotherms and isobars. Isohyets and other isometers have been introduced since then, and the areal distribution of the elements of the weather and of climate has given rise to the accumulation of almost infinite data, and endless mapping. In the great Bartholomew atlas of meteorology, several million observations were classified and charted. The study of meteorology and climatology would be practically impossible without the use of many maps. The daily weather map, issued now for wide distribution by several different governments, illustrates one of the largest fields of current map education.

The botanists making a careful study of the character and distribution of vegetation are led at once to the need of mapping types of vegetation and of plant species. And again such a map cannot be made except upon the basis of ample and varied field notes. The empty spaces upon a phytographic map are a constant challenge for more field work. And nearly all such mapping is grist for the geographer's mill.

And so on in various other scientific fields, areal distributions have been brought to map in a multitude of ways. Whole atlases of demographic data have been prepared—population density, racial distribution, education, occupation, disease, wealth, the list runs on. And in economic geography, the regional source of all the commodities of commerce, the areal density of production within the producing regions, the facilities for transportation, and routes of trade are now expected by students as part of the equipment in the study of that particular branch of geography. The dot map so familiar to all of us now, an American invention, has proved itself to be one of the best educational devices in use.

The significant thing about the map at the present time is the wide variety and large amount of information it is expected to carry, and the large part it plays in the spread of intelligence, not only in geography as such, but in so many other lines of education. And so it is fairly a part of our quest to find how it has come to serve so generously.

The Development of Map Printing.—Throughout the centuries, up until the time of Gutenberg, each map was brought into existence by the slow and painful efforts of trained draftsmen. The hundredth copy, if there were so many, took just as long and cost just as much as the first copy. As a natural result maps were very expensive and could be afforded by only only a few men of princely wealth, or by great libraries. But the intellectual world took fire with the art of

printing, beginning about1439, and in short order maps were engraved on wood, printed copies were multiplied, and the cost greatly reduced. Thereby came a great expansion of interest in the world at large. This interest grew tremendously with the opening up of the water route to India, and the discovery of America.

Copper Engraving.—Very soon after wood engraving, came line engraving on copper. In the printing arts it had risen to prominence by 1493. Much better than any other process it lent itself to the making of maps. So perfect a process is it, that in line work it has never been surpassed, and it is still in use for some government work, as in our Coast and Geodetic Survey. Most of the fine maps of the fifteenth, sixteenth, seventeenth, and eighteenth centuries were engraved on copper. The priceless old atlases of Mercator, Sanson, Blaeu, and others were copper engraved. In this process the line is incised in a perfectly polished surface of copper. Then the surface is inked, filling up the incised line. The ink is then carefully wiped off of the whole plate, but not out of the incision. Then a moist paper is pressed upon the surface of the plate, taking the ink out of the incision. The process gives perfect lines, and a great number of impressions can be taken from a plate, but the printing is very slow, and hence expensive.

Lithography in Map Printing.—Not until the close of the eighteenth century did a cheaper process appear—the process of lithography. This was invented by Senefelder of Bavaria, about 1800, and it revolutionized map making. In this case a block of fine grained magnesian limestone is brought to a perfect plane surface. Upon it in reverse the map is drawn with a pen and an oily ink. Then the surface of the stone is wet with a soft roller, but the water does not adhere to the oily ink lines. Then an ink roller is passed over the surface of the stone, but the ink does not adhere to the wet stone. The paper immediately pressed upon the stone takes the fresh ink from the inked line, giving a perfect copy. The great advantage of this process is that the stone can be put into a printing press and copies printed almost as fast as the sheets can be fed in. This process lends itself also to color printing, and it made possible the tremendous expansion in map publishing which has marked the nineteenth century as the greatest of all, in the development of cartography and geography.

Electrotyping and Photography.—But other processes, cheaper and more rapid, have come into service. Electrotyping was introduced in 1840. Photography was applied to map work in 1855. Zincography came in 1859. With these advances it was possible to take the map

from the draftsman's hands, and in a few minutes photograph it upon a sensitized zinc surface, in an hour or so have it etched in an acid bath, and ready for an ordinary printing press. This is the cheapest and most rapid of all the printing processes. It is the process used by our daily papers for the cartoons and pictorial advertisements. It is much used in cheap map work, but it is not competent to give fine, artistic work, nor does the plate stand up well under the heavy press work.

The Wax Process.—A better process was developed in America after electrotyping and photography had been brought into use, that is the wax process of engraving, introduced about 1860. It has had the largest influence on map making in this country. In this process a polished copper plate is given a thin coat of hardened beeswax and sensitized with silver chloride. The drawing is photographed upon the wax, and the wax under the lines cut away by a graver. Then the wax is warmed, to soften it, and the names, set up in ordinary type, are pressed through the wax to the copper plate. Then an electrotype is made from this surface, backed with type metal and mounted for use in an ordinary printing press. All our better wall maps and school geography and atlas maps are done by this process. It has done more than any other one thing in America to put the map to work among millions of people.

The Offset Process.—But this process is not susceptible of the refinement in line and letter which characterize either the line engraving on copper or the lithographic process. Nor is it the last word in map printing. Another process with very large promise has come above the cartographic horizon within twenty years—the offset process. In this case a sheet of zinc, or aluminum, is given a fine grained rough surface, or "burl," like that of the Bavarian limestone used in lithography. This surface is sensitized, and upon it the drawing is photographed. After the negative is developed, the gelatin is dissolved away, leaving only the deposited silver in the lines of the map. The plate is then wound round the cylinder of a rotary press, and the print made as in lithography. A wet roll is passed over the surface, followed by an ink roll, which does not leave its ink upon the wet zinc, but does leave it upon the black silver line of the map. Then follows a smooth rubber blanketed cylinder, taking the ink from the silver line, and "offsetting" it on to the print paper.

This process is exceedingly fine; lines and points down to a fraction of a thousandth of an inch are reproduced with marvelous fidelity. The press can be run at a high speed, the paper is fed automatically,

and 5,000 copies per hour can be delivered. The process is competent to give color equal to the original lithographic stone.

It seems as though this offset process may make as great a revolution in map reproduction as the lithographic process did one hundred twenty years ago. For the cheaper and the better maps can be made, the larger their possibility of service in geography and education in general.

History of Great Map-Making Establishments.—It is obvious that during most of the history of geography the making of maps has been a slow, painful, and expensive performance. Until recent decades maps have been the property of the privileged few. As a rule they have been made at all only by being subsidized from some full purse, private or governmental. In the sixteenth century Saxton's great map of England and Wales, and Mercator's beautiful map of Germany were backed by Governments. Early next century (eighteenth) map supremacy went to France, where Sanson and others, backed by the French Academy and the Government, were doing the finest of map work. Supremacy came to Germany early in the nineteenth century. The great ideal of German unity and superiority, the Hohenzollern dream, was at work. "Lernfreiheit und lehrfreiheit" had come into the world with the founding of the University of Berlin in 1810. The greatest map establishment of all time, that of Justus Perthes, was established in 1785, engraving maps on copper; but ready to take full advantage of the new and cheaper lithographic process on its arrival at the end of the eighteenth century. With the inspiration of the new regime in Germany a galaxy of great geographers came above the horizon: Baron Humboldt (1769-1859) and Carl Ritter (1779-1859)—the great geographers of the century. Heinrich Berghaus (1797-1884), Heinrich Kiepert (1818-1899), and August Petermann (1822-1878), outstanding cartographers in the entire history of the science, put their life work into the house of Perthes. Other names of almost equal fame are E. Behm, A. Supan, P. Langhans, H. Wagner, A. Ravenstein, D. Reimer, R. Andree, and E. Debes. Out of this great school have come the monumental atlases of Stieler (1817-1832), and of Andree, both still with us as the highest examples of cartographic skill; also Berghaus' Physical Atlas (1838-1842) and Von Sydow's wall maps (1838-1840)—the forerunners of the best current wall maps.

It was the inspiration of the Perthes group and work, which migrated to Edinburgh in the middle of the last century in the person of the young John Bartholomew (1831-1893), who took charge of his

father's map establishment and made it over into the Edinburgh Geographic Institute, and gave the world its most beautiful maps, the reduced Survey maps of Britain, and set the pace for the highest quality of work by the Government. The house is now in the hands of the fourth generation of Bartholomews, but it has always had to make its way as a private venture, with no subsidies from a patron or from the State.

In France the ideals of perfection in map making rose coincident with the German expansion. Vivien de St. Martin (1802-1897) began his great "Atlas Universel" about 1860, to be on a par with Stieler and Andree. Dying in 1897, the great work was continued by Schrader, but the atlas was not completed until after the Great War, the last few maps and the revision done then by Government subsidy. The French Government has generously backed the mapping of its own domain with maps of the highest quality. The same high quality of mapping is now being done by governments in Britain, Switzerland, Italy, Netherlands, Sweden, Finland, Japan, and the United States. The greatest national venture in mapping ever undertaken being our topographic atlas, in preparation by the United States Geological Survey.

The International Physical Map.—And still the ideal grows. In 1900 Professor A. Penck of the University of Berlin proposed an international agreement to make a physical map of the entire earth on a scale of 1:1,000,000, or one inch to sixteen miles. Delegates met in London in 1909, and the project was launched. Most of Europe, and large parts of Asia, Africa, and South America are now covered with map sheets of the highest excellence. Our own country is very slow. The United States Geological Survey is continually hampered by lack of funds in completing the topographic atlas, and only two or three sheets of the international map have been issued. Think what marvels in cartography we could produce with the money blown up on one battleship. Perhaps some day our Congress will be wise enough to back our Surveys with the funds necessary to place our country on a par in map making with a number of lesser and wiser lands.

Conclusion.—May I close with a paraphrase on a sentiment from the Good Book: "Of the making of many maps there is no end, and much study is a weariness to the flesh." And also with a quotation from a recent catalogue from the House of Justus Perthes: "Karten sind die peinlichste aber auch die zeitraubenste wissenschaftliche Verarbeitung geographischen Materials." From the bottom of my heart I subscribe to that sentiment.

MAPS AND BUSINESS

Map Making in the Department of Commerce

HELEN M. STRONG

Maps and Commerce.—Throughout the years maps have evolved as trade developed, and they have been the guide charts of commerce. The activities of the ancient Greeks and Phoenicians resulted in the making of maps, first of the eastern end of the Mediterranean, then of the Mediterranean, and later of the lands toward the Caspian Sea and Persian Gulf between which and the Mediterranean, traders came and went. The world map of Eratosthenes came at a time when Greek trade was reaching out in all directions. The famous Portolano maps depicted with remarkable accuracy the coast of the Mediterranean, and illustrated the Portolani or sailing directions in use among the seamen of that region, when it was the commercial center of the world and, in fact, was *the* world.

The center of commerce gradually shifted from the Mediterranean to northwest Europe, and this region around the English channel and the North Sea gradually extended its commercial relations beyond the Mediterranean and into the Far East and finally to the Americas. It was during the beginning of the world-wide expansion of Dutch trade that Gerhard Kremer engaged in making maps in the low countries, and for years thereafter Antwerp and Amsterdam were the center of cartographic activities. Few people will recognize the name of Gerhard Kremer, but many will know who is meant when the name Mercator is mentioned, for it is thus that he is generally known. Mercator means " merchant " and his great contribution was a map of the world with the parallels and meridians at right angles, which enables the sailor to use it with greater ease than had ever been the case with any other map, as the angle of his course lay true on the map. Through all the years since no map projection has superseded this for purposes of navigation, and it grew out of the great commercial activities of Flanders.

The French first became a nation of map makers when their explorations and trade were extending over the world, and in later years England and Germany came to the forefront during the early 1700's when England's colonial dominions became world wide.

The great commercial nations of today are the world's greatest map makers,—England and Scotland, Germany, and France. With its growing concern in foreign trade and foreign investments, the United

States in the near future will take its place along side these three. The need for maps in commercial circles in the United States is more than over the horizon, both because of our valuable world wide foreign trade and investment interests, and of our extensive internal commerce.

Today I am giving you what might be called the result of field work and experience in the somewhat intangible realm of commercial requirements. Some of you at previous meetings have presented papers on the way in which you would map a given area, or have discussed the relevant data which you would place upon your maps, along with the graphic method used in telling the tale. My research has led me into an entirely different field.

When I became Geographer of the Bureau of Foreign and Domestic Commerce, nearly three years ago, my equipment was a desk and a chair, the training of my good Chicago friends, and a conviction that a technically trained geographer could add to the Bureau's already efficient service in the interest of foreign trade and investment. No instructions were given and the field lay open before me. My problem was to study the Bureau and the business world it covers, and fit our geographic service into it, filling gaps which no other service has been able to cover.

During these nearly three years this research into business experience, if you may call it so, has consisted in studying the activities of the Department of Commerce in its forty district and cooperative offices throughout the United States, the forty foreign offices scattered over the world, and the home office in Washington, in their relation to the whole problem of American foreign trade and investment. What were the men in these more than eighty offices doing? Where does a geographer's contribution fit into the picture? Needless to say, it is in more than one spot, but I am going to confine myself to but one contribution which geographers can make to business, namely that in relation to maps.

How Maps Serve Business.—There are two phases to this map problem, the utilization of maps already published, and the creation of new maps, which bring into relation pertinent economic and geographic data so as to emphasize sharply a trade situation. Thus the map analyzes, interprets, and pictures for the American business man, American foreign trade and investment, and domestic trade in its relation to present and potential markets, and to the trade activities of other foreign countries.

The map is both a vehicle and a tool. No need to explain to the readers of the Annals the wide range of published maps, such as polit-

ical maps, topographic maps, climatic maps, maps showing distribution of crops and mineral resources, and maps showing ocean trade routes. Business men must have these maps in planning their trade campaigns. The general of an army would not think of laying out an important campaign without maps, and business men are coming to the same point of view. They need a political or physical map showing towns and railroads on their office walls or under their desk glasses. This may be used in marking out market areas, in plotting sales territory, in indicating lines of expansion, and distribution of salesmen or products. In studying a given situation practically every kind of map, in addition to the political or physical may be used—climatic maps, topographic maps, maps of mineral resources, soil maps, population maps—and so on down the list.

The manufacturer of oil drilling machinery called upon to deliver it to an unknown place in the interior of Venezuela wants a map showing this spot and the roads which lead to it. One man may ask for a black and white base map; another wants detail regarding the Belgian Congo; the Army Air Service may be searching for a map of South America to use in planning its flight around that continent; someone on the Pacific Coast may want a set of maps to fit into the wing frames in his office; a firm of engineers in Texas needs maps and data regarding the inland waterway along the Gulf of Mexico; others need topographic sheets to use in planning sales, and developing certain market areas. Without the map as a tool and a background, these men would be without guides, as is the motorist who goes hit or miss in a strange country and is lost. These are only a very few of the typical requests which have passed over my desk and which have been answered.

The creation of maps is a big field for the geographer. What can be accomplished by a trained geographer, who is also a cartographer, needs no comment. Business is asking for and using an increasing number of maps, and asking for maps which do not exist and which only geographers can provide. A wide range of demands for the creation of maps comes to me in Commerce. Often the request comes for a map showing market or industrial regions. Such maps cannot be sketched in by approximation, but must be based on field work and exact geographic and statistical data, comparable to the geologic data used in mapping the Physiographic Provinces of the United States, or the field studies and agricultural statistics which are back of the Map of Agricultural Regions. The maps which business men need are a complex of the political, physical, and other geographic.

Some Problems of the Map Maker.—About eleven o'clock one morning a cable was brought to me outlining the situation regarding the Indian monsoon. My problem was to put this onto a map and it was not simply a process of drawing lines, but required the background of geographic training. The monsoon was favorable in some parts and unfavorable in other parts of the country, bringing business prosperity or depression accordingly, and when American exporters had the facts before them they could, to some extent, regulate their activities in these respective areas of India. Within twenty-four hours this map, through the splendid cooperation of our drafting room, was in the Government Printing Office, and it appeared in the next issue of Commerce Reports together with a brief text explaining the situation. If any of you have tried to find out something about boundaries, location of towns and the spelling of names in Iraq and adjacent territories, the routes of railroads and motor transport lines and air service in this region, you will know something of the problem which confronted the Geographic Section when a map of this territory was required. It meant research into many documents, in more than one Department, and then the careful evaluation of these facts before they were put onto a map. A map of Nicaragua is needed to show towns, roads, railroads, and economic areas—you may search in vain for such a map—a base was found, but on it rivers, towns, and boundaries were wrong, and information had to be obtained from government files, from men who know the territory, and many other sources. Once assembled this information had to be interpreted, evaluated, and mapped. Within a month after this map was made came a request from the business world for a map showing the location of a certain town and railroad shown for the first time on this particular map of Nicaragua.

Value of Maps in Commerce.—The facts of foreign trade and investment have scarcely been mapped, and part of our problem in the Department is to map these facts of origin and destination of trade, trade routes, and foreign investments in a significant manner, relating them in some cases to geographic and economic conditions such as climate, soil fertility, land surface, mineral, agricultural, and manufacturing regions.

The Use of the Equal Area Projection.—All of these problems are dependent for graphic effectiveness not only upon the skillful presentation and relation of the facts to be shown but upon the selection of a proper base map. Whether it be a world map or map of a region, it

should be an equal area projection with as little distortion as possible. The Mercator, useful to the navigator, is for the most part a snare and delusion to the business man and the geographer, and both may well call it the "damnable" Mercator because of the untruths which it tells. Suppose an exporting house is showing its distribution of offices throughout the world. If they use the Mercator, their distribution is sadly distorted and wide areas are apparently uncovered, whereas in reality offices are comparatively near to each other. When a man is studying the relative importance of various market regions he is utterly at sea with the Mercator, as it gives him no idea of the simple fundamental facts of relative area. For this reason business men who come to my office are very much impressed with the value of an equal area world map, and more than one has asked if a wall map of this type which he can use in his office is not available. In passing, though, it might be well to mention the fact that most of these business men, and the great majority of other people, do not know that anything is wrong with the Mercator projection until they are told. They think instinctively of South America somewhat as the tail to the kite of North America, North America out of all proportion in area, and Eurasia as quite overtopping the world.

Cooperative Map Making.—Map making in the Geographic Section is not confined to maps which can be produced independently by the Department of Commerce. One of the most interesting, and as we consider it, most thoroughly worth while enterprises of the past year was a cooperative one, and involved the entire revision of a map for one of our handbooks. We wished to use that issued by a map publishing house in this country, but changes were needed. For some time this house had been trying to obtain the necessary data upon which to revise the map, but without success. We agreed to do all the research if they would make the revisions on the plates. This involved fully three months of research into postal guides for spelling; general staff maps in English, French, German, and Russian; boundary papers in the State Department; railroad and other transportation data in Commerce, State, and the Army files; and an immense number of personal conferences with men who had lived in this particular country. The result is a map of China which will give the exporter the information he desires, and the Department of Commerce the material it needs.

Government Work in Map Making.—To make satisfactory and effective maps for the commercial and investment world, a basic map must be available founded on accurate and detailed original surveys.

All the foremost countries of the world have considered the surveying and mapping of their areas a major governmental function. The United States is behind all these countries except Mexico and China, in knowledge of its physical topography. Every one is familiar with the wonderful German General Staff maps, the French General Staff maps published by the Service Geographique de l'Armee, the British General Staff maps, those of the Survey of India, and of other countries. You also know of the splendid topographic maps published by the United States Geological Survey, but perhaps you have not realized, as I did not, the way in which business men use them.

Value of Topographic Maps.—A Chamber of Commerce will put together several of these sheets and use them in planning sales campaigns in its trade territory. They need the data as to relief, drainage, and communication for their purposes. A large manufacturing concern will use them in blocking out sales territory, for topography and easy lines of communication are of importance in these days when many salesmen cover their territories by auto. A topographic map will reveal large areas of usable, and possibly relatively cheap land, suitable for the location of large manufacturing plants. This same map will show the manufacturer of agricultural implements, other things being equal, the localities in which he may sell his goods. A plant in search of water power will be saved many thousands of dollars if a reliable topographic map is available.

Engineers of all kinds need topographic maps. Irrigation engineers use them while planning reservoirs and ditches. Engineers responsible for city water supply have used a set of good topographic sheets in locating their reservoirs or conduits and pipe lines, thus saving them literally thousands of dollars which otherwise would have to be expended in reconnaissance work. Highway engineers, men concerned with transportation and numberless others need these maps. The mapping of the United States has progressed since 1889 in accordance with money available. The recent topographic sheets have been based upon careful surveys, which cover only about 35 per cent of the United States. Engineers and business men who have realized the great desirability of speeding up the mapping program of the United States, finally secured the passage of the Temple Bill about two years ago. This bill authorized the government to make appropriations through successive years so as to complete the mapping of the country within twenty years. Federal appropriations made under the Temple Bill, have, however, been made only equal in amount to those provided by

the states. On this basis, at the present rate of progress, it will take eighty to one hundred years to complete the mapping of the United States, instead of twenty years.

The Work in the Future.—Such are a few of the high spots touched during the three years of study and research into the field of maps and business. Many of you have carved out a new field in which geographers may work. To me has come this choice opportunity to build up a geographic service in the Department of Commerce, but during this three years only the fringes of the problems and opportunities connected with maps and business have been touched, for the field opens large and long ahead with many alluring by-ways.

TITLES AND ABSTRACTS OF PAPERS

PHILADELPHIA, 1926

ESTHER S. ANDERSON.—(Introduced by Nels Bengtson.)

A Geographic Study of the Potato Industry of Nebraska

Nebraska now holds an important place as a source of certified seed potatoes for the Southern states. It also supplies early and late table stock. The potato crop, valued at $7,528,000, ranked sixth in value of all crops in the state during the last five years. During the period 1917-1925, the average annual production was 8,718,000 bushels.

Nebraska has three leading centrums of potato production,—the western, central, and north central. The western district is the heaviest producing area in both certified seed and late table stock. The central district includes the Platte Valley in south central Nebraska and is the chief source of early potatoes for the commercial markets in late July, August, and September. The north central district, centered in Brown County, supplies commercial potatoes between the early crop of the central district and the late potatoes of western Nebraska.

The sandy soils of western Nebraska are best adapted for potato culture as they usually contain sufficient plant food and they are generally well drained. The loessial soils are finer textured, while the soils of the sand hills are too sandy.

Nebraska has developed a high position in regard to seed potatoes for the Southern states. The certified seed potatoes produced in the dry land High Plains region of western Nebraska mature rapidly and produce growths usually quite free from plant diseases.

The Nebraska seed production has increased from 45,000 bushels in 1921 to 121,200 bushels in 1925. The principal markets are in the states of Texas, Louisiana, Oklahoma, Georgia, Mississippi and Arkansas, Texas being the most important consumer and Louisiana second. Some seed has also been sold to places in Florida and in the Bermuda Islands.

The annual average value of the potato crop per acre during the period 1917-1925 was $88.46. It was surpassed only by sugar beets, which averaged $92.04 per acre. These were followed by alfalfa at $24.49; tame hay, $26.66; rye, $23.03; corn, 19.59; and winter wheat at $19.25 per acre.

In the dry land area of western Nebraska the potato crop is more certain than many other crops because the potato is more tolerant of drought. If the soil has been carefully prepared and kept free from weeds, there is sufficient conserved soil moisture to supply the needs of the plant until rain.

Another economic value of the potato is the value added to the soil when it is used in crop rotation. Grain crops following potatoes receive considerable benefit from potato in rotation. The rotation of crops also decreases the percentage of diseases in potatoes.

O. E. Baker.

Changes in Land Utilization in the United States since the War.

The returns from the 1924 agricultural census, and likewise the annual estimates of the Department of Agriculture, show an increase since 1919 in agricultural production greater even than the increase in population. This has taken place despite a decrease of farm land, of crop land, and of pasture land in farms; despite a decrease in number of horses and mules (considered jointly), of cattle and of hogs on farms January 1; despite a decrease in number of farms, farm population, and number of persons engaged in agriculture.

How has the American farmer contrived to produce more food, fibres and other agricultural commodities on a contracted acreage, with a smaller number of livestock, and with less labor? Principally in four ways:

1. By increasing the yield per acre of the food crops, 30 per cent in 1924 over 1919, according to the Census figures, but only 5 per cent during the five-year period 1920-1926 over that in the period 1917-1921, according to the annual estimates of the U. S. Department of Agriculture.

2. By increasing the production of meat and milk per unit of feed consumed by about 10 per cent between the two 5-year periods. The production of feed crops was about one per cent less in the period 1922-1926 than in the period 1917-1921, while the pasturage available was about two per cent greater, the net increase in feed production being, therefore, probably less than one per cent. The increase in production of meat and milk combined was about 16 per cent. However, the feed released by the decrease in horses and mules accounts for over a third of this apparent increase in efficiency, so that the actual increase in efficiency is reduced to about 10 per cent. This is greater, however, than the increase in human population.

3. By increasing the production of cotton, flax and tobacco, considered jointly, nearly 20 per cent in the period 1922-1926 over that in 1917-1921. This was entirely achieved by increasing the acreage, the average yield per acre decreasing about three per cent.

4. The production of wool decreased about 2 per cent.

The increase in crop land occurred mostly in the Great Plains region, while a decrease greater in amount and extent is shown in most of the originally forested eastern portion of the United States. The changes in number of livestock were similar to the changes in crop acreage. The increase in efficiency of livestock in transforming feed into food was probably greatest in the more progressive portions of the United States,—in the Corn Belt, the Hay and Dairy region, and the West, but this is a matter of opinion and not susceptible of statistical proof.

C. H. Birdseye.

Precarious State of United States Topographic Mapping.

(No Abstract.)

Malcolm H. Bissell.—(Introduced by Ellsworth Huntington.)

Geographic Aspects of the Pennsylvania State Highway System.

Geographic principles enter largely into the planning and construction of a state highway system. Studies of the amount, character and destination of highway traffic give further illustrations of geographic factors. Pennsylvania, on account of the variety of its topography, resources, and products and the excellence of its highway department, affords an unusually good example of the relation of geographic, economic, and engineering principles in the development of a state highway system. Some of these relations were pointed out, use being made of data furnished by the Pennsylvania Department of Highways.

S. W. Boggs.—(Introduced by Helen M. Strong.)

A New Projection for Maps of the World.

For certain purposes, including the representation of many statistical facts, it is desirable that maps of the world should represent all areas in their true proportions, that the parallels of latitude should be straight parallel lines, and that the form of land masses should be preserved as well as possible. Each map projection has its own distinctive characteristics, as it attains or approximates one or more ideal properties of a map at the expense of other ideal properties. Any new map projection is of interest as giving a greater range of choice when maps are to be compiled.

The map projection which is presented is an equal-area projection which is a mathematical mean between the Sanson sinusoidal and the Mollweide homolographic projections. It has less angular distortion than the sinusoidal, and less distortion in linear scale and in the ratios between latitude and longitude than the homolographic.

Account is taken of the fact that in the northern half of the Eastern Hemisphere, greater human importance attaches to high latitude areas in the west, and to low latitude areas in the east. An adjustment is made in the projection in order to represent the form of these important land areas more perfectly.

Chas. F. Brooks.

The Glacial Anticyclone: A Review.

(No Abstract.)

I. J. Curnow (Miss).—(Introduced by Chas. F. Brooks.)

A Contrast of the Standard Topographic Maps of Great Britain and the United States of America.

The standard maps of the Ordnance Survey and of the United States Geological Survey originated in different cartographic epochs. The first Ordnance Survey map dates from 1801, that is to say, the first sheets of the standard 1/63360 were published while methods of topographic surveying and mapping were still in an experimental stage. The U. S. Geological Survey was instituted in 1879. By this time the possibilities of topographic maps were more accurately known, more widely appreciated, and the American cartographic department was able to benefit by the experiences of others.

The incentives underlying the work of the two bureaus were different. In Great Britain military needs gave the first impetus to

topographic mapping, and proved the dominating influence in the evolution of cartography. In the United States economic considerations were paramount.

Different geographic conditions have conduced to a different evolution and different results. Great Britain is a small area, long settled, with no great range of height. Therefore it was feasible to attempt large scale accurate maps of the whole country. Such a policy was not warranted in the United States. The resultant differences between the standard maps of Great Britain and the United States are justifiable.

The Ordnance Survey presents the most varied, the most complete and the most accurate series of small scale topographic maps in the world: while the large scale issues are unique in their uniform excellence and accessibility. The U. S. Geological Survey presents a number of maps as special responses to the varied needs of a country in the making.

W. Elmer Ekblaw.—(Introduced by W. W. Atwood.)

The Geographic Response Complex of a Primitive Polar People.

The Polar Eskimo living in northwest Greenland are the farthest north people in the world. Their relation to their physical environment is simple and direct, unmodified by alien influences.

A chain of favorable conditions, unusual for regions so far north, permits continuous human occupancy of their country. The racing tides through Smith Sound between Kane Basin prevents the formation of ice even in coldest and calmest winters; the open water in relative proximity to the land tempers the circumpolar cold; at the near-freezing temperature of the water the carbon dioxide content is high. The rich store of carbon dioxide and the continuous sunlight for four months of the year favor the growth of an abundant phytoplankton, the ultimate source of food of all the higher forms of life. Numerous birds and animals frequent the adjoining sea-waters. A few species of land animals, vitally critical in the domsetic economy of the Polar Eskimo, feed on the sunny grass covered slopes enriched by the guano from the bird-rookeries. The land and sea-animals supply the Eskimos with all resources necessary for life.

Consequently the Polar Eskimo are hunters, not because of low mental capacity but because they have no other source of food, clothing, fuel, light, or material for artifacts. They are entirely and exclusively carnivorous, their sole food being the flesh and blubber of the animals they hunt and kill. Their fuel and light come from blubber

burned in their small lamps. Their clothing is made from furs and skins and feathers, all tanned soft and pliable by chewing. Practically all their equipment for the trail, the chase, and the home are from animal parts.

The sites of their villages both summer and winter are determined by conditions of relief, exposure, temperature, wind, snowfall, and icelay. They must be near, and seasonably accessible, to the haunts of the game. Their winter houses are of stone, their summer tents of sealskins, and their temporary shelters on the trail or in the hunting camps are of wind-packed snow. Their trails and travels are dependent upon the condition of the sea—whether open or covered with ice. Their sole means of transportation on land and ice is by dog-sledge, and the sledges and the methods of harnessing, hitching, and driving the dogs have been adapted to the physical conditions of the trail. The kayak, distinctly constructed in response to local conditions, is their one way of transportation over open sea.

Consequent upon the rigor of the natural conditions, and the paucity and monotony of their resources, the Polar Eskimo have developed a keen, alert mentality and have evolved a social and economic organization that reflects the environment as faithfully as does their material culture.

S. P. Ferguson.

The Meteorological Results of the First Greenland Expedition of the University of Michigan.

(No Abstract.)

V. C. Finch.

Progress in the Field of Mapping of Detailed Geographic Interrelationships.

In recent years papers read at meetings of this Association have emphasized the mechanical difficulty inherent in any attempt to represent in concrete map form the abstraction of a geographic interrelationship. The difficulty has been met hitherto by showing the elements of the natural landscape in one or more maps and by placing in juxtaposition for comparison a map of the cultural landscape on the same base. Neither of these maps pictures the interrelationship which must be read between them, and both fall short of the ideal which the geographer may set for himself in this direction. To make a map which shall picture geographic interrelationships between all of the

several elements of the cultural and natural landscapes is admittedly almost impossible of accomplishment. It is believed, however, that the map presented with this paper makes some progress in that direction.

The map referred to represents the work of a group of students in a small area in southern Wisconsin. It is upon a specially prepared base with a scale of four inches to one mile. It pictures the major forms of land utility by the use of color and the topographic situation of land by three degrees of intensity in these same colors. Thus woodland on steep slopes is shown in dark green, on essentially flat land in light green and on intermediate slopes in intermediate green. So also for crop land and permanent grassland with yellow and orange respectively. Surface soil condition is shown by a series of letters; drainage, direction of slope, condition of roads and other features are shown by symbols. From this one map it is possible for an observer to learn, for example, that a certain locality having level topography and sandy loam soil is not used for tilled crops but is kept in permanent pasture due to poor drainage.

A further advantage of this type of map is its suitability for close office analysis. When properly executed this map consists of a large number of unit geographical complexes or expressions of relationship between certain aspects of slope, soil, drainage, location, and use. Each of these units is delimited and is capable of measurement with the planimeter. Each type of complex is therefore capable of expression in percentage of the total or of one another. This method of analysis applied to the map described yielded results surprising in some degree because of their lack of conformity with generally accepted notions regarding the locality.

J. Paul Goode.

The Map as a Record of Progress in Geography. Presidential Address.—Published in March Annals, 1927.

Richard Hartshorne.—(Introduced by Chas. C. Colby.)

Location as a Factor in Geography.

Previous studies of the iron and steel industry and of the lake traffic of Chicago have brought forth the importance and complicated nature of the factor of relative location. Such studies have called for general methods by which the geography of activities of those kinds may be studied. This paper presents a method for studying the geography of any manufacturing industry to determine the importance of the

different factors affecting the location of or distribution of the plants of that industry.

The location of a factory affects the success of the industry almost entirely through its effect on the cost factors of manufacturing, the optimum location being that where the total costs are less than the selling price obtainable by the maximum amount.

As direct or operating costs are much more important than indirect or overhead costs, fixed investment on land, buildings, etc., is usually a minor factor affecting the general location of industries. The principal factors can be reduced to labor costs and relative location or "locus" of the place where the factory is, in reference to three sets of places or areas—those of raw material production, those of power and fuel resources, and those of consuming markets. Certain other factors may be important in particular industries; certain other factors are very important locally in influencing the site of factories within a district; other factors listed are of very slight importance in influencing factory location. With the major exception of the factor of labor, and other very minor exceptions, all of the factors affecting location are dependent primarily on the locus of the place where the factory is with reference to other places. Consequently general advantages for transportation are usually significant advantages for manufacture, and the importance of seaport districts and interior rail centers is made clear.

The relative importance of the different factors influencing the location of industries may be measured objectively and even quantitatively. Three of the major factors can be expressed in terms of amounts of different commodities to be transported, the factor of power and fuel being expressed by the tons of coal that would be used to supply the total requirements. The relative importance of these three factors depends on the quantities of the commodities required, their perishability, the unit cost of transportation, and the extent of concentration of the producing or consuming areas.

The effect of the labor factor on location depends largely on the mobility of the labor, varying for different classes of labor—skilled, unskilled or "parasitic." It can be measured by computing, for each class, the labor cost per ton of raw materials, fuel, or finished products involved and calcuating how great a change in labor costs would offset a change in transportation costs resulting from changed location.

The importance of the factor of locus or relative location in the field of manufacturing geography in particular, but in general in all human

geography, emphasizes the lack of agreement among geographers on any common understanding of the factor and calls for a definite concept on which agreement may be possible, and which will permit of direct classification and more or less definite measurment.

A. T. Henry.

The Bückner Cycle in United States.

(No Abstract.)

William Herbert Hobbs.

The First Greenland Expedition of the University of Michigan.

The base of the expedition was established on the shore of the Maligiak Fiord, about fifty miles east of Holstensborg, where a meteorological station was at once set up and balloon work undertaken, under the direction of Mr. S. P. Fergusson, loaned by the United States Weather Bureau to the expedition. In all, some ninety pilot balloon ascensions were made and followed with the theodolite to an average height of about 7,000 meters. Many were followed to 10,000 meters, and one to about 14,000 meters.

Balloons-sondes, making use of the new Rossby deflating device, were sent up and in three instances the meteorographs which they carried were recovered with records intact after reaching, in one case a height of 1,500 to 2,000 meters. In two cases planned for greater heights, though the device seemed to operate, the balloons were lost; but almost miraculously one of the meteorographs was later recovered intact after having reached the extreme height of 8,000 meters. No ascensions by balloons-sondes have hitherto been carried out in Greenland.

An exploring party consisting of Hobbs, Gould, Church and Belknap with four Greenlanders traveled by umiak, canoe and on foot, and reached the margin of the inland-ice about one hundred miles east of Holstenborg. The entire journey occupied twenty-two days and was shortened by the failure to find game in the interior region. The inland-ice in this district presents an unusually gradual ascent and a way of penetrating it was found without great difficulty.

Pilot balloons were sent up from the margin of the inland-ice and followed with the theodolite to a maximum height of 2,000 meters. Others were sent up from above the ice itself and were followed over its surface throughout to a maximum height of 5,500 meters. These ascents are the first ever to have been made at such positions either in Greenland or the Antarctic.

Evidence of two glaciations of the hinterland portion of the coastland ribbon was found, and the entire area has been glaciated throughout.

Psychrometer and wind observations were carried out by Professor Church at three-hour intervals both day and night during the twenty-two-day journey. Self-registering instruments loaned by the U. S. Weather Bureau have been left with Governor Bistrup at Holstensborg, who has arranged to have them read regularly throughout the coming year. Observations with a tide-gauge, loaned by the United States Coast and Geodetic Survey, have been regularly made at Camp Little. A triangulation survey of an area of about 1,000 square miles of rugged territory has been carried out by Mr. Belknap, and in all a score of mountain peaks having altitudes up to 4,300 feet have been occupied as stations. A study of raised beaches has been carried out by Professor Gould.

HENRY F. JAMES.—(Introduced by J. Russell Smith.)

Some Influences of Geographical Factors on the Agricultural Development of Southeastern Pennsylvania.

Southeastern Pennsylvania, for the purpose of this paper, includes as political divisions the counties of Adams, Bucks, Chester, Delaware, Lancaster, Montgomery, and York. In this region, the Piedmont Physiographic Province, which includes the largest part of the area, is more varied than usual. The normal crystalline upland surface is here associated with limestone plains and valleys and sandstone and shale lowlands. The territory also extends slightly beyond the borders of the Piedmont, to the east and southeast into the Atlantic Coastal Plain and westward into the Appalachian Mountains. It is a land of physical diversity, climate being the only physical factor that possesses any degree of uniformity. Few places of equal area in the United States present such physical variations.

This varied physical setting, combined with its advantageous location and its early start, helped to produce within this area an important and diversified type of agriculture that in the aggregate places it in a favorable agricultural position. It is an important corn, hay, winter wheat, and tobacco region. In the production of market milk, it is found among the first three sections of the United States. It has a monopoly on the country's production of mushrooms. Special products, such as apples, eggs, poultry, and nursery products are outstandingly important. In addition its farmers are interested in beef cattle, hogs, peaches, rye, barley, truck products, oats, and potatoes.

It is truly a land of differences. Many and varied were its early settlers. Outstanding differences exist within county borders, as well as between individual counties. It contains some of the best farming land in the United States, as well as some of the poorest. Farms that are considered the show places of the state and nation are at times not far removed from areas that are practically worthless for agricultural purposes. Farm land in one county is valued at $286 per acre as compared to $66 an acre elsewhere. Farm land is sold at a price as high as $500 an acre and as low as $40 an acre within the border of the same county. Its agricultural history has been one of constant change. As new economic conditions developed, the farmer was compelled to constantly readjust his activities or perish financially. Under duress better relationship between economic activities and environment has been slowly obtained. This has been mostly the result of trial and error. The situation is complex, but underneath the swirling surface waters can be detected some of the geographic relationships that exist between man and his natural environment. Topography, soil, climate, position, resources have played an important part in the development of Southeastern Pennsylvania.

MARK JEFFERSON.

The Sea Island Coast. (Read by title.)

Genial, lordly whites, by the hands of outnumbering slaves, grew rice on the delta of a mighty river, or cotton of longest fiber on islands or higher parts of a coastal lowland where forests of longleaf pine are interrupted by linear cypress sinks that mark old earthquake fissures along the coast. Proud their mansions, well built by skillful slaves who had been trained by owners careful of their human property. The slaves, though coerced to much toil, maintained a certain happiness with a lowly standard of life.

At emancipation rice and cotton culture vanished and the mansions are rotting in the forest. Genial white grandchildren inhabit more modest homes in a village isolated in the forest as farmers, mechanics, storekeepers—workers at all intelligent tasks among still outnumbering blacks, who are now less cared for, untrained, almost unschooled and stupid. They contribute heavy, unintelligent masculine effort for occasional hours for occasional dollars. They are even happier than of old with a low material scale of comfort still but a prized freedom to idle as much as they please. The toiling whites, conscious of a historic handicap for which they had no responsibility, contemptuous and careless of the blacks that they cannot regard as fellow Americans, genial

by inheritance, land poor, vaguely expectant of mysterious blessings that may come from outside wealth at any moment, talk, work and pray for the communications that shall release them from their isolation.

LESTER E. KLIMM.—(Introduced by Frank E. Williams.)'

Aranmore.

The aim of this short paper was to show how poverty of resources may keep an area long settled and not far from the higly developed civilization of Europe in an economic state that is simple and almost primitive.

It described the conditions on the largest of the Arans, a group of small islands lying across the mouth of Galway Baff off the West Coast of Ireland. Here there are still some two thousand people obtaining a meagre cash income by fishing from small boats, raising a few cattle on the almost bare limestone uplands of this rain-drenched island, or, in bad fishing years, laboriously gathering kelp to be burned and sold to British traders for the extraction of iodine.

They produce most of their own food, either by fishing or raising a few cattle or hogs or cultivating small patches of potatoes on the thin soil. Sugar, tea, and flour they obtain by trading fish and cattle with the mainland. Peat for fuel is also obtained in this way, as there is no turf and hardly a stick of wood on the island. They are forced to eke out this expensive fuel by burning dried cow-dung, very carefully saved.

For shelter and clothing, they are almost entirely self-sufficient. Their houses are built of the local limestone and thatched with rye from their stony fields. Only the rafters and doors have to be brought in from outside. The furniture is often made from boards that have drifted in to the rocky inlets of the west coast from some wreck on the Atlantic.

The Islander, as he hoes his little field of potatoes or pulls the oars of his "curragh" on a fishing trip, is clothed, with the exception of the store cap on his head, entirely in island products. His clothes, throughout, are made of homespun wool from sheep that pick a poor living from the scanty grass that grows in cracks in the rocks. The cow-hide moccasins or "pampooties" on his feet probably come from the hide of a cow killed on the islands.

Everyone speaks the native Irish or Gaelic, although most of the people on this island also have a passable English. On the smaller islands of the group almost no English is spoken.

In these bare, wind-swept, rain-soaked, poverty-stricken islands is found the native haunt of much of the wildly tragic Irish literature

in the original Gaelic which is just being made known to the world through the students of the so-called "Irish Renaissance."

Although archaeological remains show it to have been settled at least five hundred years before the Christian Era and, in spite of the fact that it is but thirty-five miles from Galway and less than a day's journey from modern Dublin, the Island of Aranmore is still in almost the same economic state that it was when the Firbolgs made their last stand there in the legendary days long before the Roman Legions came to Britain.

ROBERT S. PLATT.

A Classification of Manufactures, Exemplified by Porto Rican Industries.

To expose the great and varied geographic significance of manufactures, a classification based on localizing factors was presented for Porto Rico. Industries of the first group use local materials and export their products. Their processes prepare for transportation by compacting materials, eliminating waste matter, or reducing perishability. Sugar mills, tobacco factories, coffee cleaning plants, and fruit canneries, belong in this first group. For the second group, materials are imported and the market is local. The materials are better transported; the finished products are more bulky or more perishable. Bakeries, printing shops, machine shops, clothing factories, and furniture factories are examples. For the third group both materials and markets are local. The materials are of common occurrence near most markets. Some of these industries, such as ice plants and bottling works, make products more bulky or perishable than their materials and are located close to centers of population. Others, such as lime kilns, brick yards, and salt ponds, make products more transportable than their materials and are located close to sources of material. The fourth group is of industries importing their materials and exporting their products. For the making of embroidery and straw hats transportation of both materials and products is less significant than another local advantage, that of cheap labor.

ALEXANDER MCADIE.

New Data on Weather Maps.

The present weather maps of the world stress pressure reduced to sea-level. Temperature is given in isotherms not corrected for time or elevation. In making a world weather map the incongruity of linking a midnight temperature with a noon temperature is apparent yet on a

small scale this is the practice for temperature, winds and clouds. In a previous paper before the Association (Special Maps for Storm movements: Annals Ass. Am. Geog. Vol. XV, No. 3, Sept., 1925) the radical suggestion was made that isobars and isotherms be subordinated to isovents, such as geostophic winds, which can readily be obtained by nephoscopic observations of the lower clouds, 1,000 to 1,500 meters.

It is further suggested that for forecasting, data showing the strengthening or weakening of hyperbars and infrabars (formerly called Centers of Action) would be of material help in anticipating continued dry and continued rainy periods. The Icelandic and Aleutian "lo-bars" and the West Pacific and Azores "hi-bars" undoubtedly determine the paths of individual disturbances. Sir Napier Shaw has recently suggested that differences of sea and air temperature over the Atlantic may furnish a clue to the behavior of the Atlantic "lo-bar," which in this paper is likened to a pump, while any adjacent "hi-bar" is regarded as a reservoir, in turn distributing air but where the time element is important. The memorable dry season of 1921 and the abnormal wet season of 1924 in Great Britain are shown to be directly associated with displacement of the Icelandic "lo-bar."

Ultimately by the use of tephigram areas, values of energy available from a given mass of ascending air might be indicated in connection with the likelihood of thunder-storms.

K. C. McMurry

Work of the Michigan Land Economic Survey.

This survey attempts a complete inventory of the resources of various counties in Northern Michigan. Both physical and economic phenomena are inventoried, and the data are presented in map form. The work is essentially geographic in character. It is of value as basic in detailed geographic reports, while the technique of field work and presentation contains much of value and interest to geographers.

G. T. Renner.—(Introduced by J. Russell Smith.)

Geographic Elements in the Concepts of Heaven.

Human institutions originate from specific needs of man in his environmental relations. Man's religious institutions arise from emotional urges which drive him to compensate for the inadequacies of his environment and the unsatiated desires of his experience. In accordance with these, nearly every race of men have conceived of an

ideal environment as a place to live in during after life—a Vahalla, a Nirvana, a Heaven. But differences in environments give rise to different ideal constructions of heaven.

The tropical forest man conceives of heaven as a remote village in a land of inactivity, with no heat or mosquitos, and plenty of wives and yams. The Eskimo places heaven in the warm earth and hell in the cold sky. The Comanches conceived of heaven as a prairie full of bison; the Todas, as a land of pastures and dairies. Heaven to the Hebrew was a city on a height, walled off from the desert nomad. The Mohammedan pictures heaven as a delightful, well watered oasis and hell as a hot, scorching place with hot desert winds to breathe and bitter desert water to drink.

These diverse concepts of heaven would seem to have arisen through man trying to minimize the evils and emphasize the good elements in his earthly environment, when he conceives of a future state.

Ellen Churchill Semple.

The Templed Promontories of the Ancient Mediterranean.

A study of the numerous promontories of the Mediterranean coast revealed the fact that a large number of them were crowned with temples or altars in ancient times; that a still larger number were sacred to certain deities whose name they bore and who were the patron gods of the ancient seamen; and that these same promontories in the eastern Mediterranean Basin are crowned at the present time with shrines or chapels to Saint Nicholas, patron saint of sailors in the Greek Catholic hagiology, while many of those in the western Basin are marked with shrines or churches to the Virgin Mary, the *Stella Maris* of the Roman Catholic world. A comparative study of these promontories in relation to the prevailing winds in the summer season of navigation revealed a steady demand for divine aid on the part of the ancient seaman attempting to round these headlands. The columned temple was his prayer in stone. Promontories and sanctuaries persist today; only the Divine incumbents change.

Edward L. Stevenson.

Geographical Activities of the Casa de la Contrataciòn.

The paper discussed the circumstances leading to the establishment of the Casa de la Contrataciòn or Indian House in Seville; the development of its several departments of control touching Spain's interests in the New World; the special importance attaching to its geographical activities; the duties of its several officers; early Spanish cartography

of the New World, its sources, its control, its dissemination; special reference to certain early Spanish official cartographers, and to the important records left by them.

HELEN M. STRONG.

Maps and Business. (Published in March ANNALS, 1927.)

Throughout the years maps have evolved as trade developed, and they have been the guide charts of commerce. From the time of the ancient Greeks and Phoenicians, on through the commercial development in the Mediterranean, and later in northwest Europe, maps have been the outgrowth of commercial enterprises. Gerhard Kremer, better known as Mercator produced his maps of Europe and the famous Mercator map of the world during the period when Dutch trade was expanding to the utmost limits of the world. Similarly, the French, British, and Germans became interested in maps as their commercial horizon expanded.

Today the great commercial nations are the world's greatest map makers—England and Scotland, Germany, and France. With its growing concern in foreign trade the United States is also taking its place with these three other nations of map makers.

The Bureau of Foreign and Domestic Commerce has a vital concern in this question of maps, and to the geographer of the Bureau has come the responsibility for studying the needs of the commercial world for maps and atlases. There are two phases to this map problem, the utilization of maps already published, and the creation of new maps, which bring into relation pertinent geographic and economic data so as to emphasize sharply the trade situation. The creation of maps is an open field for the geographer, and only the professionally trained geographer has the background from which the most significant commercial maps can be produced. The facts of foreign trade and investment have scarcely been mapped, and a geographer's responsibility is to map these facts of origin and destination, trade routes, and foreign investments, in a significant manner, relating them in some cases to geographic and economic conditions, such as climate, soil fertility, land surface, mineral, agriculture, and manufacturing regions.

S. S. VISHER.

Geography of the Indiana Oolitic Limestone Industry.

The Indiana oolitic limestone quarries are located in southwest central Indiana, near Bedford and Bloomington, and the chief mills are in these cities. This district produces more than half of the output

of American building stone, and over 90 per cent of the cut stone. It is said to be unsurpassed in output by any foreign quarry district. The stone is widely used for facing or trimming costly buildings, 21.5 per cent being used in 1925 for school buildings, 21 per cent for office buildings, and 47 per cent for bank buildings, city halls, courthouses, churches, hospitals, hotels, clubs and post offices. Thus in 1925 less than 10 per cent was used for dwellings. Although the stone is shipped to nearly all American states and Canadian provinces, over three-fourths is used within about three hundred miles of Bloomington. Within three hundred miles the Chicago, Detroit, Cleveland, St. Louis, Cincinnati, Indianapolis, Louisville, Milwaukee, and several other large and rapidly growing cities. The district is crossed by, or is near to, a number of important railroads connecting two or more of the large cities. It is also near the center of the eastern half of the U. S. and recently contained the center of the nation's population.

The industry is affected not only by its favorable location in respect to diversified markets and railway transportation but also by other geographic influences, notably climate and local relief. Winter cold and snow interfere much less with quarrying or with the mills than they do in Vermont, Wisconsin and even in northern Ohio; the summer's heat does not interfere with the industry. The limestone district is in the unglaciated section of moderate relief. It has no heavy overburden of glacial material, requiring removal. The relief aids quarry drainage and the disposal of wastage. The hilliness and generally poor soil of the locality reduces the value of the land for agriculture and hence cheapens it. The relief is not great enough, however, to interfere seriously with railroad construction. Indeed the limestone belt is somewhat less rugged than the tracts adjoining to the east and west, which conditions lead to the location along it of the chief north-south railway of the area (the Monon) and the development at the intersection of this line, and east-west lines, of Bedford and Bloomington, which were small cities before the stone industry begun.

DERWENT S. WHITTLESEY.

Devices for Obtaining Geographic Data in the Field.

(No Abstract.)

ELLA M. WILSON.—(Introduced by Mark Jefferson.)

Farmers and Farming in Cambridgeshire.

Cambridgeshire, a part of the largest farming district in England, has thirty-eight out of every hundred workers engaged in agriculture.

So it seemed a good place to try to find out what is meant by an English "farmer," and how he compares with his American prototype.

To an Englishman, a "farmer" is a man who rents from Crown, Church, noble or County Council a farm of one hundred acres or more. He, in turn, hires laborers living in a hamlet near by to do the farm work. The landlord supplies the capital in the form of the land, the buildings, and sometimes part of the equipment; the "farmer" supplies skill in farm procedure and usually his own implements and stock; the laborers supply the brawn. They are three distinct classes.

An ambitious laborer may become a "small holder" or a "small farmer," but he continues to rent the land. In most cases, indeed, he has no desire to own it.

Crops and methods differ on down and fen; the large farms with sheep are on the downs, the smaller with cattle on the fen.

In home comforts, in education, and in social position, the English farmer fares poorly in comparison with the farmer in America whom Lord Bryce has characterized as our "Average Man."